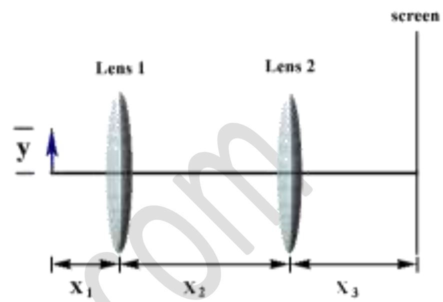
Q- An object 5 cm high is located 73 cm from a converging lens of focal length f_1 = 45 cm. A second converging lens of focal length f_2 is located 178 cm from the first lens. An image of the object is to be formed on a screen 200 cm from the second lens. What must be the focal length f_2 of the second lens so that the final image appears on the screen?



The lens formula gives the relation between the object distance u image distance v and the focal length f as

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

For the first lens using the signs according to sign conventions

u = -73 cm
v =?
f = 45 cm

We have $$\frac{1}{v}-\frac{1}{-73}=\frac{1}{45}$$

Or $$\frac{1}{v}=-\frac{1}{73}+\frac{1}{45}=\frac{-45+73}{73*45}=\frac{28}{3285}$$

Gives v = 3285/28 =117.3 cm

This image will behave as an object for the second lens at a distance x_2 – v form it on the right side and forms an image on the screen which is x_3 = 200 cm from the lens hence if the focal length of the second lens be f_2 then for the second lens with proper sings we have

u = - (178 – 117.3) = - 60.7 cm
v = + 200 cm
f_2 =?

Using lens formula for the second lens we get.

$$\frac{1}{200}-\frac{1}{-60.7}=\frac{1}{f2}$$

Or $$\frac{1}{f2}=\frac{60.7+200}{200*60.7}=\frac{260.7}{12140}$$

Or f_2 = 12140/260.7 = 46.57 cm.

Thus the focal length of the second lens must be 46.57 cm.